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Diamond Wire Saw for Precision Machining of Laser Target Components

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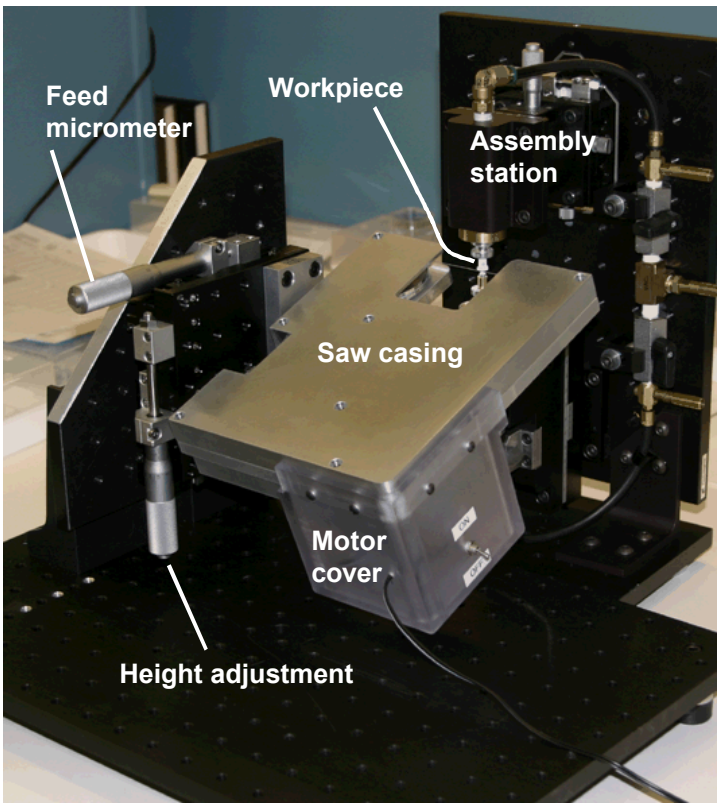
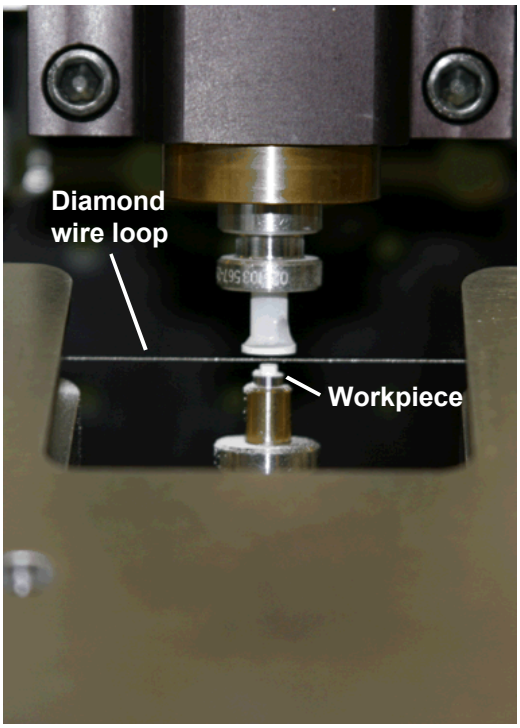
The fabrication of precision laser targets requires a wide variety of specialized meso-scale manufacturing techniques. The diamond wire saw developed in this study provides the capability to precisely section meso-scale workpieces mounted on the assembly stations used by the Target Fabrication Group. This new capability greatly simplifies the fabrication of many types of targets and reduces the time and cost required to build the targets.

A variety of materials are used to fabricate targets, including metals, plastics with custom designed chemical formulas, and aerogels of various densities. The materials are usually provided in the form of small pieces or cast rods that must be machined to the required shape. Many of these materials, such as metals and some plastics, can be trimmed using a parting tool on a diamond turning machine. However, other materials, such as aerogels and brittle materials, cannot be adequately cut with a parting tool. In addition, the geometry of the parts often requires that the workpieces be held in a special assembly station, which excludes the use of a parting tool. In the past, these materials were sectioned using a small, handheld coping saw that used a diamond-impregnated wire as a blade. This miniature coping saw was effective, but it required several hours to cut through certain materials. Furthermore, the saw was guided by hand and often caused significant damage to fragile aerogels. To solve these problems, the diamond wire saw shown in Figure 1 was developed.





Front view of wire cutting through a Ta_2O_5 workpiece

Figure 1. Diamond wire saw (left) and a close-up view of the diamond-impregnated wire cutting through a Ta_2O_5 workpiece (right)

The diamond wire saw is designed to machine through materials that are mounted in the Target Fabrication Group's benchtop assembly stations. These assembly stations are the primary means of aligning and assembling target components, and there is often a need to machine materials while they are mounted in the assembly stations. Unfortunately, commercially available saws are designed for very different applications and are far too large to be used with the assembly stations. Therefore, a custom diamond wire saw was designed and constructed.

The diamond wire saw cuts through workpieces using a continuous loop of diamond-impregnated wire of length 840 mm. The wire loop runs around several idler pulleys and is driven by a simple geared DC motor that rotates at 17 rpm. The linear speed of the wire is 107 inches/minute. The saw is oriented at an angle of 20º from horizontal, so the operator can view the wire through the cutout at the front end of the saw. When looking through a microscope or camera with a horizontal line of sight, the operator can clearly see the wire as it cuts through the workpiece, as shown in the right side of Figure 1. The saw is mounted on a two-axis stage that allows the operator to align the wire with the workpiece. To cut through the workpiece, the operator drives the wire through the workpiece by turning the feed micrometer.

An image of the interior of the diamond wire saw appears in Figure 2. This picture was taken after removing the protective cover plate from the saw.

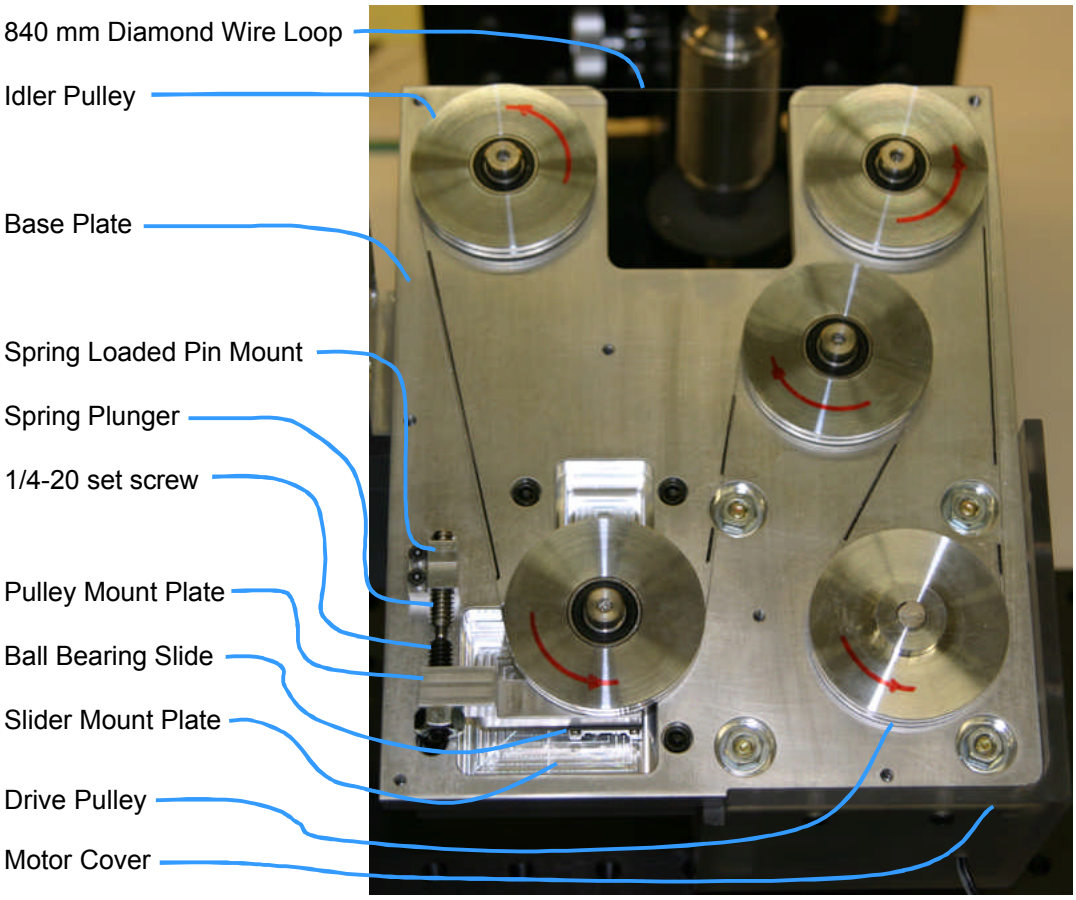


Figure 2. Interior of the diamond wire saw

An exploded view showing the design of the diamond wire saw appears in Figure 3.

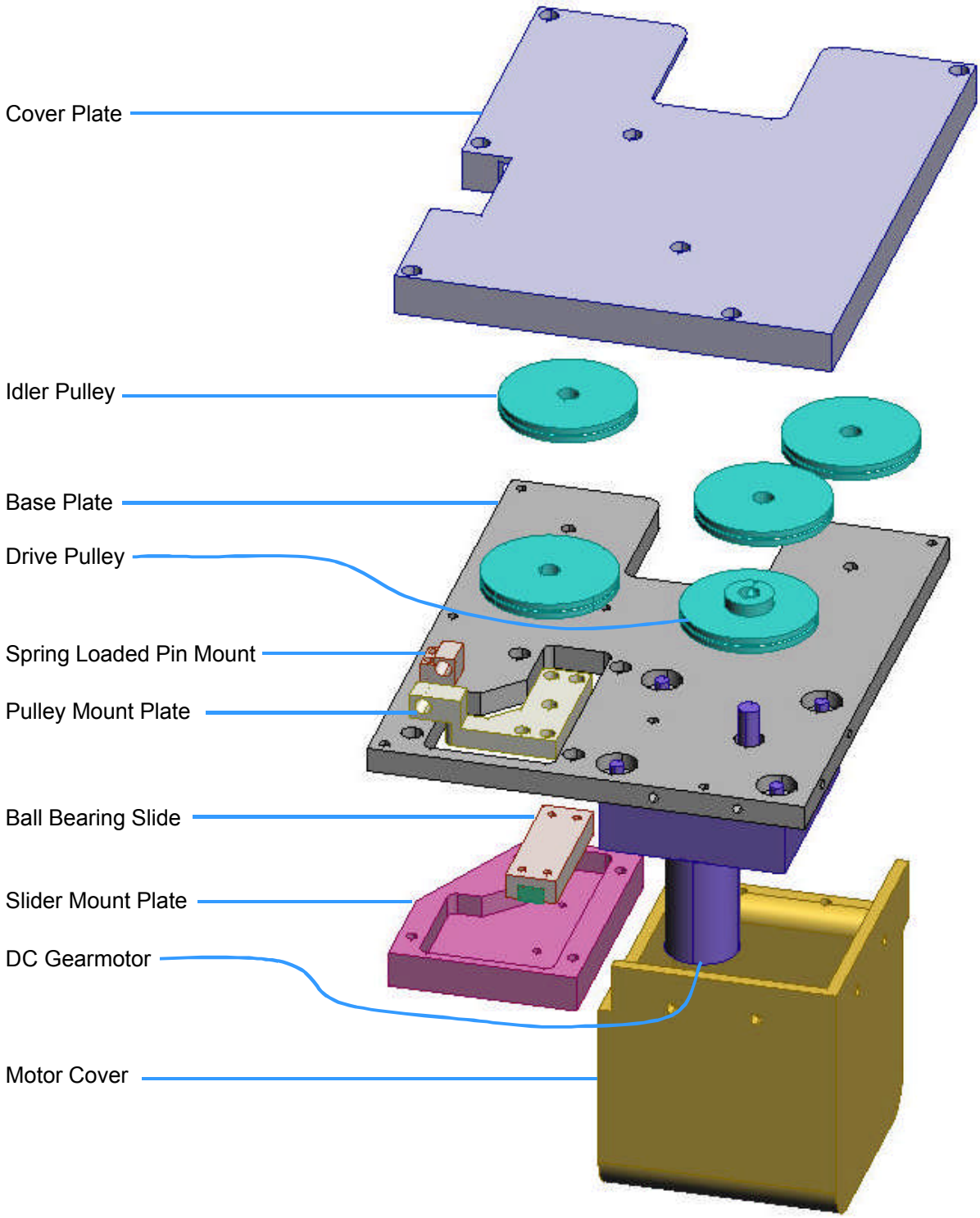


Figure 3. Exploded view of the diamond wire saw

Figure 4 lists the components of the diamond wire saw.

Item	Description / Drw No.
Slider Mount Plate	AAA05-503945
Pulley Mount Plate	AAA05-503946
Spring Loaded Pin Mount	AAA05-502947
Drive Pulley	AAA05-503948
Idler Pulley	AAA05-503949
Cover Plate	AAA05-503950
Base Plate	AAA05-503951
Motor Cover - polycarbonate	Fabricated at LLNL
High-Torque Round-Nose SS Spring Plunger W/O Locking Element, 1/4"-20 Thrd, 3-13 lb End Force	McMaster Carr Item 8476A11
Subfractional-hp DC Gearmotor 24 VDC, 17 Rpm, 17 In-lb Running Torque	McMaster Carr Item 6409K25, a.k.a. Molon Part No. CHM-2418-3M
Precision Ball Bearing Slide Assembly Low Profile, 1" Stroke, 10# Dynamic Load Capacity	McMaster Carr Item 6203K62, a.k.a. Del-Tron Model E-2
Diamond Wire Loop, 840 mm length	0.3 mm Thick Diamond Loop Wire for SXJ-2 Wire Saw from MTI Corp.
Shoulder Screw	M 6x6 T300, M5-0.8 thread
Bearing	SKF Model 626-2RS1

Figure 4. Components of the diamond wire saw